Article

Copper deficiency in yaks on pasture in western China

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Abstract — The clinical signs of a disorder in yaks (*Bos grunniens*), known locally as "swayback ailment," in the Qing Hai-Tibetan Plateau are described. The purpose of this study is to investigate the possibility that swayback ailment is iron (Fe)-induced copper (Cu) deficiency. The mean concentrations of Cu in soil and forage from affected areas and unaffected areas are similar and within the normal ranges. The mean concentrations of Cu in blood and hair from the affected yaks was significantly lower ($P < 0.01$) than that in unaffected yaks. The mean concentrations of Fe in soil and forage were significantly higher ($P < 0.01$) in affected than in unaffected areas. Affected yaks showed a hypochromic microcytic anemia and a low level of ceruloplasmin. Oral administration of copper sulphate prevented and cured the disease. We conclude that "swayback disorder" of yaks is caused by secondary Cu deficiency, mainly due to the high Fe content in forage.

Résumé — Carence en cuivre chez les yacks au pâturage dans l'ouest de la Chine. Les signes cliniques d'une affection chez les yacks *(Bos grunniens)*, connue localement sous le nom d'«affection d'ensellement», dans le plateau Qing Hai-Tibet sont décrits. Le but de la présente étude consiste à examiner la possibilité que l'affection d'ensellement soit causée par une carence en cuivre (Cu) provoquée par le fer (Fe). Les concentrations moyennes de Cu dans le sol et le fourrage des régions touchées et non touchées sont semblables et se situent dans les valeurs normales. Les concentrations moyennes de Cu dans le sang et le poil des yacks touchés étaient considérablement inférieures ($P < 0{,}01$) à celles des yacks non touchés. Les concentrations moyennes de Fe dans le sol et le fourrage étaient considérablement supérieures ($P < 0{,}01$) à celles des régions non touchées. Les yacks touchés présentaient une anémie microcytaire hypochrome et un faible taux de céruléoplasmine. L'administration orale de sulfate de cuivre a prévenu et guéri la maladie. Nous concluons que l'«affection d'ensellement» des yacks est causée par une carence en Cu secondaire, principalement attribuable à la forte teneur en Fe du fourrage.

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Introduction

A disorder, known locally as "swayback ailment," characterized by depraved appetite, diarrhea, pica, poor growth, emaciation, dyskinesia (walking slowly a slight with rock and signs of shivering and trembling), and swayback is seen in yaks (*Bos grunniens*) in the eastern region of the Qing Hai-Tibetan Plateau. The prevalence is estimated at 50% to 60% and the mortality may reach 70%.The affected area is part of the Huanghe Shouqu grassland area and is located at 33°12′–34°18′ N latitude and 99°42′–101°12′ E longitude, where the provinces of Qinhai, Gansu, and Sichuan meet, at an average elevation of 3300 m above sea level. The annual precipitation is 760 mm. The average temperature is only 1.1°C and there is no completely frost-free season. Thirty percent of the pasture is swamp meadows; the soil is acid (pH 6.2–6.5) and abundant in humus. The grassland vegetation is mainly *Achnatherum splendens; Leymus seclinum* and *L. multicalis; Stipa krylovii, S. laxiflora, S. bungeana,* and *S. capilacca;* and *Carex kansuensis, C. enervis,* and *C. scabriostris.* It was an excellent autumn-winter range of native pasture for communal use until 1995, when the government allocated both the pasture and yaks to individual families for use in all 4 seasons, in an attempt to improve the local herdsmen's nomadic life and productivity. As a result, 20 families had about 4500 yaks that were affected by the "swayback ailment," representing 58% of the total of 7700 yaks living the Huanghe Shouqu grassland pasture area. It is suspected that the underlying cause of the syndrome is copper (Cu) deficiency.

Studies of yaks reared in confinement suggested that they may be more susceptible to Cu deficiency than other species of ruminants (1). There are 2 types of Cu deficiency — induced or direct. The former occurs when sulphide is trapped as ferric sulfide by soluble iron (Fe)

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in the rumen (2) and the Cu is adsorbed by insoluble ferric sulphide compounds (3). It has been shown in cattle that the copper status is reduced when as little as 250 mg/kg Fe (dry matter) as saccharated ferrous carbonate is included in the diet (4). The latter occurs when the Cu content in forage is lower than normal. The purpose of this study was to investigate 1) the possibility that swayback ailment is Fe-induced Cu deficiency, and 2) the effect of copper supplementation on the prevalence of "swayback ailment."

Materials and methods

Animals

Sixty growing animals, 2 to 3 y old (110 ± 15 kg), were selected for the study from 4500 affected yaks that were used for meat production. All showed signs of "swayback ailment." The selected yaks were randomly divided into 2 groups and allocated to affected pastures (30 per pasture), where they grazed for 60 d. Group I was used as control and received no Cu. Group 2 was supplied with a bolus of $CuSO_4$, 5 g/yak once a month. The clinical signs were recorded by direct observation while following the herd on the pasture, noting in particular any manifestation of animals being affected by the syndrome. A 3rd group, consisting of 30 unaffected animals selected from an area where the disease is not seen, was allocated to unaffected pastures (30 animal per pasture), where they grazed for 60 d. Body weights for all the experimental yaks were obtained by platform balance on days 1, 30, and 60.

Sample collection

The grazing experiment began on 10 June 2004. Blood samples were collected on days 1, 30, and 60 from the jugular vein into trace mineral-free tubes for analysis of mineral contents in whole blood and for hematologic and biochemical examination in serum. Blood was kept cool at the collection site and subsequently transported to an animal nutrition laboratory for further preparation and analysis. Hair from each yak's neck was also sampled and washed, as described previously (5). Samples of forage were collected at 30-day intervals from 60 randomly distributed different sites on 3 pastures (20 samples/pasture). To reduce soil contamination, herbage samples were cut 1 to 2 cm above ground level. Composite forage samples of the available species were dried at 60°C to 80°C for 48 h and then ground to facilitate chemical analysis for mineral content. Soil samples were taken from the surface layer (0 to 30 cm) and well mixed, using a 30-mm diameter cylindrical core. Four cores per paddock were bulked and placed in polythene bags. The soil samples were dried out at 60°C to 80°C for 48 h and passed through a 10-mm sieve.

Analysis of mineral contents in blood, hair, forage, and soil

Copper, Fe, cobalt (Co), and calcium (Ca) levels were determined by atomic absorption spectrophotometry. The selenium (Se) level was examined by hydride-generation atomic absorption spectrophotometry. Sulfur (S) and phosphorus (P) levels were determined by nephelometry (6). The molybdenum (Mo) level was determined for all treatments by using flameless atomic absorption spectrophotometry. The accuracy of analytical values was checked by reference to the certified values of elements in the National Institute of Standards and Technology Standard Reference Material bovine liver SRM 1577 (7).

Table 1. Effect of supplemented copper on body weight gains of yaks

	1 d	30 d	60 d	ADG kg/d
Group 1	213.1 ± 13.1	217.2 ± 12.1	219.1 ± 13.7	0.1 ± 0.02
Group 2	217.6 ± 10.7	224.6 ± 11.6	232.6 ± 12.9	0.25 ± 0.06
Group 3	229.6 ± 17.7	242.6 ± 19.1	256.6 ± 18.6	0.27 ± 0.07

ADG — Average daily weight gains

Hematological and biochemical examination

Hemoglobin (Hb), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), packed cell volume (PCV), and red blood cell (RBC) values were determined by routine methods (8). Biochemical analyses, which included superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), catalase (CAT), ceruloplasmin (Cp), lactate dehydrogenase (LDH), alkaline phosphatase (AKP), and creatinine (Crt), were determined by using test kits provided by the Nanjing Jiancheng Bio-Engineering Institute. r-Glutamy-transferase (r-GGT), cholesterol (Chol), urea nitrogen (BUN), Ca, and inorganic P in serum were determined by using test kits provided by Matsuda Planning and Industrial Company.

Statistical analyses

The data are presented as means ± standard deviations. The differences were assessed by Student's *t*-test. Experimental data were analyzed by using a statistical package (SPSS version for windows; SPSS, Chicago, Illinois, USA).

Results

Yaks affected by the swayback ailment demonstrated characteristic depraved appetites, pica, growth retardation, diarrhea, emaciation, dyskinesia, and swayback. The more seriously affected yaks had difficulty in keeping up with the herd and appeared to die of exhaustion. There was a tendency for the heart and respiratory rates to be increased. Unaffected yaks (group 3) and those supplemented with $CuSO_4$ (group 2) showed significantly higher average daily gain ($P < 0.01$) than affected yaks (group 1). Body weight changes are given in Table 1.

The Fe content of forages in the soil and forage samples from the affected areas were significantly higher ($P < 0.01$) than those in the unaffected areas. The other mineral contents in the soil and forage samples were within the normal ranges in all areas (average macromineral concentrations of forage in the affected areas were 0.177 ± 0.015%, 6681 ± 678 μg/g, and 473 ± 82 μg/g for S, Ca, and P, respectively, compared with 0.167 ± 0.018%, 5843 ± 867 μg/g, and 481 ± 72 μg/g for S, Ca, and P, respectively, in unaffected areas; average micromineral contents of forage were 6.40 ± 1.32 μg/g, 0.78 ± 0.25 μg/g, 0.082 ± 0.065 μg/g, and 1.70 ± 0.96 μg/g for Cu, Mo, Se, and Co from affected areas, respectively, compared with 7.11 ± 1.36 μg/g, 0.80 ± 0.21 μg/g, 0.83 ± 0.67 μg/g, and 1.77 ± 0.95 μg/g for Cu, Mo, Se, and Co, ARTICLE

Table 2. Effect of supplemented copper on contents of mineral elements in whole blood

	Group 1			Group 2			Group 3		
	1 d	30 d	60 d	1 d	30 d	60 d	1 d	30 d	60 d
Cu (μg/g)	0.29 ± 0.18	0.28 ± 0.17	0.31 ± 0.15	0.28 ± 0.19	0.81 ± 0.26	0.91 ± 0.31	0.95 ± 0.24	0.89 ± 0.31	0.91 ± 0.76
Fe (μg/g)	656 ± 65	658 ± 81	649 ± 76	617 ± 39	607 ± 26	591 ± 31	516 ± 28	518 ± 39	497 ± 31
S (mmol/L)	38.7 ± 2.12	35.1 ± 3.71	32.7 ± 3.81	35.2 ± 4.72	38.9 ± 2.91	41.2 ± 3.71	38.7 ± 2.91	39.9 ± 3.71	36.5 ± 2.9
Mo (μg/g)	0.016 ± 0.007	0.018 ± 0.006	0.015 ± 0.006	0.015 ± 0.007	0.016 ± 0.006	0.017 ± 0.009	0.018 ± 0.007	0.019 ± 0.008	0.018 ± 0.09
Se (μg/g)	0.183 ± 0.03	0.188 ± 0.06	0.176 ± 0.07	0.98 ± 0.09	0.186 ± 0.08	0.179 ± 0.05	0.177 ± 0.06	0.173 ± 0.04	0.183 ± 0.03
Co (μg/g)	0.53 ± 0.26	0.65 ± 0.19	0.67 ± 0.31	0.59 ± 0.32	0.61 ± 0.31	0.69 ± 0.12	0.58 ± 0.5	0.61 ± 0.21	0.63 ± 0.11
Ca (μg/g)	120 ± 35	127 ± 26	137 ± 19	117 ± 31	119 ± 29	126 ± 36	128 ± 31	127 ± 26	119 ± 31
P (μg/g)	276 ± 71	239 ± 39	257 ± 69	268 ± 81	267 ± 71	269 ± 69	291 ± 87	287 ± 65	291 ± 59

Cu — copper; Fe — iron; S — sulfur; Mo — molybdenum; Se — selenium; Co — cobalt; Ca — Calcium; P — phosphorus

Table 3. Effect of supplementing copper on the mineral elements in the hair of yaks

	Group 1			Group 2			Group 3		
	1 d	30 d	60 d	1 d	30 d	60 d	1 d	30 d	60 d
Cu (μg/g)	3.51 ± 1.11[a]	3.71 ± 1.21[a]	3.62 ± 1.31[a]	3.59 ± 1.21	5.94 ± 1.21	6.57 ± 1.26	5.98 ± 1.12	6.37 ± 1.37	6.92 ± 1.97
Fe (μg/g)	796 ± 81	812 ± 92	789 ± 72	759 ± 69	776 ± 81	801 ± 92	491 ± 87	469 ± 83	459 ± 79
S (%)	3.96 ± 0.32	3.87 ± 0.33	4.17 ± 0.31	3.57 ± 0.31	3.67 ± 0.21	4.07 ± 0.31	3.47 ± 0.51	3.65 ± 0.46	3.97 ± 0.37
Se (μg/g)	0.51 ± 0.13[a]	0.53 ± 0.12	0.61 ± 0.17	0.49 ± 0.11	0.57 ± 0.12	0.53 ± 0.13	0.61 ± 0.12	0.58 ± 0.17	0.48 ± 0.12
Co (μg/g)	0.97 ± 0.21	0.99 ± 0.37	0.89 ± 0.21	0.97 ± 0.31	0.91 ± 0.21	0.87 ± 0.19	0.91 ± 0.11	0.89 ± 0.97	0.87 ± 0.26
Ca (μg/g)	1987 ± 422	1921 ± 411	1998 ± 412	2112 ± 419	2231 ± 496	1961 ± 371	1967 ± 397	1998 ± 416	2012 ± 387
P (μ/g)	119 ± 23	124 ± 31	121 ± 29	137 ± 41	118 ± 41	129 ± 37	159 ± 29	141 ± 39	112 ± 27

[a]$P < 0.01$
Cu — copper; Fe — iron; S — sulfur; Se — selenium; Co — cobalt; Ca — Calcium; P — phosphorus

respectively, from unaffected areas; average macromineral concentrations of soil are 0.95 ± 0.12%, 13 843 ± 1319 μg/g, and 61.58 ± 12.7 μg/g for S, Ca, and P, respectively, in affected areas, compared with 0.96 ± 0.13%, 14 285 ± 1531 μg/g, and 63.67 ± 13.1 μg/g for S, Ca, and P, respectively, in unaffected areas; average micromineral contents of soil are 14.79 ± 5.41 μg/g, 1.30 ± 0.31 μg/g, and 5.73 ± 2.16 μg/g for Cu, Mo, and Co, respectively, from affected areas compared with 16.08 ± 5.68 μg/g, 1.24 ± 0.35 μg/g, and 5.98 ± 2.65 μg/g for Cu, Mo, and Co, respectively, from unaffected areas). The concentrations of mineral elements in the blood and hair are shown in Table 2 and Table 3, respectively. The Cu content in the blood and hair of affected yaks was significantly lower than that in normal and supplemented yaks ($P < 0.01$). The Fe content of the blood and hair was significantly ($P < 0.01$) higher in the affected yaks as compared with that in the normal yaks. The Mo and S content of the blood and hair were within the normal ranges in all groups. In all supplemented yaks, the Cu content in the blood and hair reached normal values within 30 d, when the appetite and vigor had also improved. When the experiment ended, the signs of disease had disappeared completely. In the control animals, the syndrome described previously continued to development in many yaks, and 20% of the yaks died of exhaustion. There were no significant differences in the clinical parameters of temperature, pulse, and respiration between treated and control groups.

The hematological values for affected yaks are given in Table 4, and compared with the normal values previously reported (9). The average Hb concentration, PCV, MCV, MCH, and MCHC in affected yaks were significantly lower ($P < 0.01$) than reference ranges and those in unaffected yaks. The abnormal blood indices indicated a hypochromic microcytic anemia in yaks with the swayback ailment. All the biochemical values were within the normal ranges, except for the elevated serum cholesterol and the decreased superoxide dismutase (SOD), glutathione peroxidase (GSH-PX), ceruloplasmin (Cp), and catalase (CAT) in the serum of affected animals (Table 5).

Discussion

The clinical signs shown by the yaks with swayback ailment were similar to those shown by cattle with Cu-deficiency, namely, poor weight gain/weight loss, poor haircoat, pale mucous membranes, anemia, and neonatal ataxia (10). Impaired immune competence is the likely result of Cu deficiency in cattle (11,12). Cu deficiency has a direct impact on the ability of cattle to mount a normal response to viral infection (13). Calves with Cu deficiency have lower percentages of lymphocytes than control or Cu-supplemented calves and tend to show a decreased cytokine response to disease challenge (14).

Previous studies showed that Cu levels > 6 μg/g and 5 μg/g dry matter (DM) in soils and forage are safe for ruminants (15,16). In the our study, the content of Cu in the soils and forage from affected and unaffected regions were similar and within normal ranges by those standards, but the Fe content of the soil and forage in affected areas was significantly higher ($P < 0.01$) than those of the unaffected areas. The Fe requirement of cattle in forage is only 35 to 100 μg/g (dry matter) (17). In this study, the Fe content in forage was 1075 μg/g, which would be excessive for yaks. Elevating the levels of Fe in the diet of cattle and sheep has been shown to lower Cu absorption, so likely the elevated Fe levels in soil and forage in areas where the affected yaks grazed had the same effect. Various authors have reported that feeds and pastures with higher Fe interfered with the

Table 4. Hematological values in yaks at the start and end of the study

	Group 1		Group 2		Group 3		Reference range[a]
	Start	End	Start	End	Start	End	
Hb (g/L)	93.6 ± 18.6[b]	92.8 ± 19.1[b]	90.6 ± 19.7[b]	136.5 ± 11.6	132.5 ± 11.9	136.6 ± 11.6	138.5 ± 16.5
RBC (10^{12}/L)	9.7 ± 2.8	9.6 ± 2.3	9.9 ± 2.9	8.7 ± 1.8	8.2 ± 2.3	8.1 ± 2.6	7.97 ± 1.2
PCV (L/L)	0.39 ± 0.024[b]	0.38 ± 0.031[b]	0.38 ± 0.054[b]	0.49 ± 0.024	0.42 ± 0.034	0.41 ± 0.037	0.45 ± 0.014
MCV (fL)	40.3 ± 4.6[b]	39.8 ± 5.2[b]	38.9 ± 5.9[b]	56.9 ± 5.7	52.0 ± 5.1	51.4 ± 5.6	56.85 ± 3.7
MCH (pg)	9.7 ± 2.9[c]	9.7 ± 3.2[c]	9.2 ± 1.9[c]	15.7 ± 1.9[c]	16.2 ± 3.1	16.9 ± 2.3	13.67 ± 2.1
MCHC (%)	23.9 ± 3.6[b]	24.2 ± 3.1[b]	23.5 ± 3.9[b]	27.6 ± 4.2	31.1 ± 3.2	32.8 ± 3.6	24.17 ± 3.1

[a]From reference 9
[b]$P < 0.01$
[c]$P < 0.05$
Hb — hemoglobin; RBC — red blood cell; PCV — packed cell volume; MCV — mean corpuscular volume; MCH — mean corpuscular hemoglobin; MCHC — mean corpuscular hemoglobin concentration

Table 5. Biochemical values in serum at the start and end of the study

	Group 1		Group 2		Group 3		Reference range (23)
	Start	End	Start	End	Start	End	
SOD (μmol·s^{-1}/L)	12.1 ± 1.6	12.5 ± 1.7	12.4 ± 1.9	16.2 ± 2.7	17.2 ± 3.7	16.9 ± 4.7	17.0 ± 6.7 (23)
CAT (μmol·s^{-1}/L)	17.53 ± 2.32	17.36 ± 2.35	17.99 ± 2.17	25.50 ± 3.29	27.50 ± 3.18	28.67 ± 3.29	29.33 ± 2.86 (23)
GSH-Px (μmol·s^{-1}/L)	15.48 ± 3.61	15.18 ± 3.32	15.08 ± 3.27	18.80 ± 3.73	18.30 ± 3.63	17.85 ± 3.69	17.75 ± 3.61 (23)
AKP (μmol·s^{-1}/L)	0.97 ± 0.35	0.98 ± 0.38	0.95 ± 0.33	0.96 ± 0.37	0.95 ± 0.35	0.96 ± 0.41	NA
LDH (μmol·s^{-1}/L)	31.5 ± 4.18	31.6 ± 3.18	30.9 ± 5.28	27.8 ± 2.62	29.8 ± 1.12	30.3 ± 1.23	NA
r-GGT(mmol/L)	0.14 ± 0.03	0.15 ± 0.06	0.12 ± 0.04	0.13 ± 0.03	0.12 ± 0.03	0.14 ± 0.04	NA
Chol (mmol/L)	31.5 ± 5.1	31.6 ± 3.9	30.2 ± 5.1	25.8 ± 3.6	25.0 ± 3.7	23.7 ± 4.7	22.2 ± 7.73 (9)
BUN (mmol/L)	9.51 ± 2.3	9.23 ± 2.9	9.55 ± 2.9	9.28 ± 2.9	9.17 ± 2.7	10.25 ± 3.1	10.32 ± 1.21 (9)
Crt (μmol·s^{-1}/L)	168.5 ± 7.8	171.6 ± 7.1	175.5 ± 6.9	126.3 ± 6.9	129.6 ± 2.98	126.6 ± 3.65	110.50 ± 2.71 (24)
Cp (g/L)	0.130 ± 0.013	0.129 ± 0.017	0.126 ± 0.016	0.176 ± 0.025	0.177 ± 0.023	0.174 ± 0.021	NA
Ca (mmol/L)	2.16 ± 0.13	2.26 ± 0.15	2.56 ± 0.16	2.87 ± 0.59	2.81 ± 0.68	2.73 ± 0.65	2.93 ± 0.94 (9)
P (mmol/L)	1.73 ± 0.47	1.83 ± 0.72	1.99 ± 0.65	1.89 ± 0.76	1.86 ± 0.79	1.89 ± 0.81	1.86 ± 0.83 (9)

SOD — superoxide dismutase; GSH-Px — glutathione peroxidase; CAT — catalase; Cp — ceruloplasmin; LDH — lactate dehydrogenase; AKP — alkaline phosphatase; Crt — creatinine; r-GGT — r-Glutamy-transferase; Chol — cholesterol; BUN — urea nitrogen; Ca — calcium; P — inorganic phosphorus

absorption of Cu, resulting in a secondary Cu deficiency for ruminants (18).

The content of Cu in blood depends on the amount of Cu stored in the liver (15), so low concentrations of Cu in the blood indicate exhaustion of the liver reserves. The highest and lowest values for Cu in whole blood in the affected group were 0.59 μg/g and 0.05 μg/g, respectively. In cattle, average blood Cu values of < 0.50 μg/g (normal 0.7 to 1.3 μg/g) are a sign of severe Cu deficiency (19).

The Cu content of hair is also a sensitive indicator for diagnosing Cu deficiency, since, as previously reported in cattle, the Cu values for liver and hair or blood are positively correlated (19). The mean Cu concentration in the hair of the affected yaks of 3.61 ± 1.21 μg/g, well below the 5.5 μg/g characteristic of secondary Cu deficiency in cattle (20). In affected yaks supplemented with $CuSO_4$, the Cu content in blood reached normal levels by the 30th day and the appetite and vigor had improved. When the experiment ended, the signs of disease had disappeared completely.

Hemoglobin is an Fe-containing (0.334%) conjugated protein that has physiological association with oxygen and its transport in blood. Normal Hb concentrations for most mammals are 130 to 150 g/L (21). The mean hemoglobin level from the affected yaks was significantly lower ($P < 0.01$) than that in unaffected yaks (Table 4). Lower concentrations may be linked to Cu deficiency (22). However, low Hb concentrations do not always occur when the low Cu in blood is a result of high Fe in forages. The mean Cp content of blood from yaks in groups 2 and 3 was significantly higher ($P < 0.01$) than that from those in group 1 (Table 5). Under normal conditions, most of the Cu in serum is present as Cp, which plays an essential role in promoting the rate of Fe saturation of transferrin and thus in the utilization of Fe by bone marrow. So, Cu deficiency not only markedly reduces the content of Cp, but it causes anemia, which type varies between and within species: In rats, lambs, rabbits, and pigs, the anemia is hypochromic and microcytic, but in chickens and dogs it is normochromic and normocytic. In cattle and adult sheep, it is hypochromic and macrocytic (25). In captive yaks with Cu deficiency, microcytic anemia was observed (26); in affected yaks in this study, the anemia was hypochromic and microcytic. Thus, it is reasonable to conclude that the disease of yaks in the Eastern region of the Qing-Hai Tibetan Plateau is a secondary Cu deficiency caused by the high Fe in forages.

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The Pet Lover's Guide to Canine Arthritis and Joint Problems

Schulz K, Beale B, Holsworth I, Hudson S, Hulse D. Elsevier Saunders, St. Louis, Missouri, USA, 2006, ISBN 1-4160-2614-2. US$21.95.

The Pet Lover's Guide to Canine Arthritis and Joint Problems is a brightly illustrated paperback book, written in a concise style. It is part of a series of "Pet Lover's Guides" that currently include volumes on first aid and emergencies, cat and dog skin diseases, and natural healing for cats and dogs. The series promises to release books in the near future on canine and feline behavior, nutrition, and weight management and exercise for dogs. This guide was published under the auspices of the American College of Veterinary Surgeons and bears the ACVS seal.

When I was first presented with this book, I read it and formed some impressions, but recognized that while I'm certainly a dog owner and "pet lover," I'm not part of the dog-owning general public that the book is aimed at. So I lent the book to a couple of dog enthusiasts of my acquaintance to get their opinions. Both had largely the same impressions that I had.

On the positive side, this is a wonderfully illustrated book with many helpful photographs and illustrations that do an excellent job of graphically amplifying the text. The text is very comprehensive, covering the definition of osteoarthritis, its signs, causes, and diagnosis; weight management; nutritional supplements and nutraceuticals; physical rehabilitation; and medical, surgical, and alternative therapies for arthritis. The book then presents 6 "joint-specific" chapters on arthritic conditions and their management involving the shoulder, elbow, carpal, hip, stifle, and hock joints. The book concludes with a glossary and 7 appendices on assorted topics, including resting energy requirements, body condition score, and nonsteroidal anti-inflammatory drugs (NSAIDs) (dose, side effects, mode of action).

Having said all this, how can I best describe my problem with this book and why I can't recommend it? I have 2 terrific teenage daughters who think the world of their parents. They're interested in how their parents met and their relationship…up to a point! Beyond that they'll confront us with the popular catch phrase "too much information!" That's the problem with this book in a nutshell. Although in a paperback format, it comprises well over 300 pages from cover to cover. It includes discussion of the composition of cartilage matrix, including collagen, proteoglycans, and glycosaminogylcans; a description of the modified Outterbridge scale for osteoarthritis grading; and a discussion of prostaglandins and the actions of cyclooxygenases 1 and 2. The authors describe the roles of omega-3 fatty acids, arachadonic acid, eicosapentanoic acid, lipoxygenase, and leukotrienes in the inflammatory cascade. You're starting to get the picture. What "pet lover," lacking a doctorate in biochemistry, could possibly want all this information? None that I know of and certainly neither of the 2 dog owners who reviewed this book with me!